 ROUGH DRAFT

DEVELOPMENT WORK DONE ON TRANSISTORIZED CRYSTAL CONTROLLED CONVERTER

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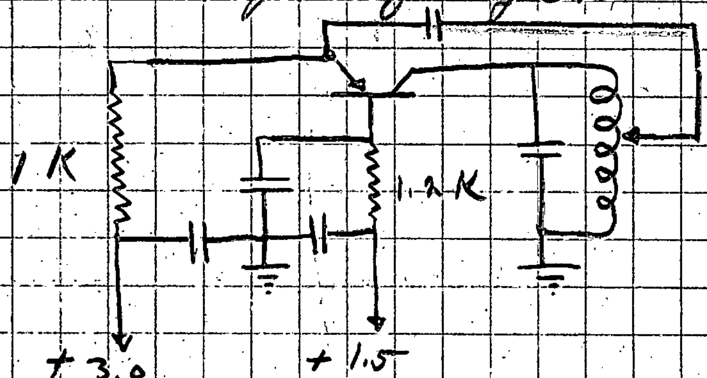
Very little information was available on transistorized RF frequency converters in general and none on the crystal controlled variety in particular. Because of this, a bit of experimentation went into the development of this converter.

In the interest of simplicity of adjustment in the field when it will become necessary to change frequencies it was felt the oscillator portion of the converter should behave in a manner similar to a Pierce crystal oscillator in as much as no adjustments would be necessary. The point contact type of transistor (RCA 2N33) was first tried in this role. The crystal was tried in the base return circuit as well as between emitter and base. Both arrangements left much to be desired. The value of the components ~~were~~ was rather critical. A load across which the crystal controlled output could be developed for mixer injection was a stumbling block. A load which permitted the oscillator to take off at all desired frequencies would, at the same time, allow spurious frequencies to be developed which were evident by the many "birdies" heard near the output frequency of the converter. Resonating the mixer input would pull the crystal out of an oscillating condition unless the amount of injection was ~~fax~~ far below optimum. A supply voltage of at least 4.5 was necessary in the case of the 2N33.

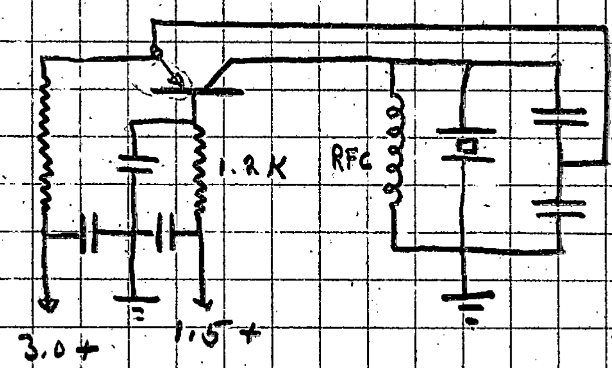
All of the above mentioned undesireable features were overcome by the use of a Philco SB100 surface barrier type of transistor. No data or circuit diagram was obtainable on a surface barrier transistor equivalent of a Pierce Crystal Oscillator.

The following circuit diagram was supplied by Philco in their "Application notes on The Philco Surface Barrier Transistor."

High Frequency Oscillator.

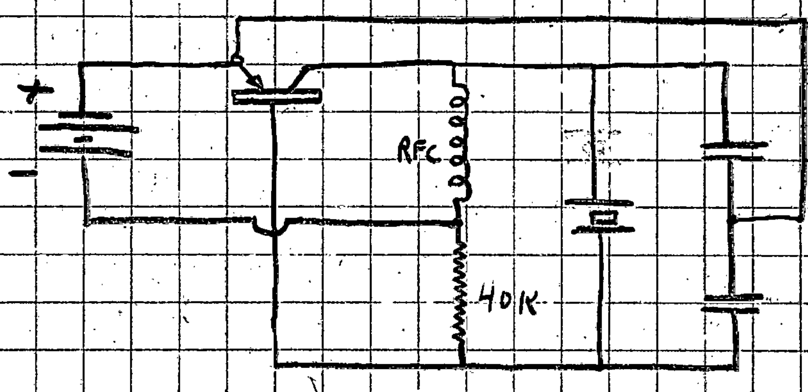


This is an adaptation of the Hartly Oscillator. Using a capacitance instead of an inductive voltage divider, a crystal in place of the parallel tuned circuit and a shunt fed DC supply for the collector the following circuit was developed.



Tho no trouble was experienced in getting this circuit to oscillate it proved to be far from satisfactory. A value of RFC which permitted the circuit to oscillate with any crystal in the desired frequency range would also allow the oscillator to oscillate simultaneously at a frequency determined by the inductance of RFC and the value of the capacitance voltage divider network. A swamping resistor across RFC of a low enough value to kill the undesired oscillation would from oscillating at the crystal frequency. The same results were experienced when a resistor was tried in series with RFC. The circuit would not oscillate at any frequency with a resistor in place of RFC even tho the resistor was a high value and the supply voltage was raised in order to compensate for the IR drop in the resistor. Grounded emitter as well as grounded collector adaptations of the above circuit were tried. Results were the same. An inductance was a "must" in the collector return circuit. A value of inductance that would allow the circuit to oscillate with any crystal within the desired frequency range would, at the same time, permit oscillation at a spurious frequency.

During these experiments the extreme low value of base current was noted. A self biasing base arrangement with the base returning to ground thru a resistor of a large value instead of thru the 1.2K resistor to 1.5 volts positive was the idea that led to the development of the "Bugless" oscillator circuit illustrated below



RFC is no longer tied to the base RF-wise. Instead the base is connected to RFC thru the biasing resistor. This large value of resistor in series with RFC as far as the oscillatory circuit is concerned discourages RFC from taking off on its own. An additional advantage with this circuit is no tapped supply voltage is necessary. With the values chosen the circuit would oscillate with any crystal from 3.0 to above 13.5 megacycles. Increasing the value of R. [illegible] tance voltage divider network would allow the oscillator to oscillate at lower frequencies but at the expense of decreased output when higher frequency crystals were used.

The oscillator is coupled by means of a capacitance RF voltage divider into the mixer emitter. Signal-wise the mixer (also an SB100) is of the grounded emitter variety. This arrangement permitted optimum mixer injection with no undesired pulling of the oscillator.

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Optimum component values for the rest of the converter were determined experimentally with no difficulty.

As a matter of passing interest it was noted the SB100 would oscillate crystal controlled with no inductance in its circuit providing the base was left floating DC-wise. The strength of oscillation however was too feeble to be ~~xf~~ put to practical use. Mixer injection by means of a RF divider network described above but in the collector circuit would cause the mixer to oscillate and finally the sensitivity of the converter minus the output coupling stage was quite independent of the supply voltage. No detectable change in sensitivity was noted whether the supply was one or two cells ($1\frac{1}{2}$ or 3 volts). With the output stage a very pronounced increase in sensitivity was noted when the supply voltage was increased from $1\frac{1}{2}$ to 3 volts.

A value of coupling between mixer and output stage and between output stage and output lead somewhat greater than optimum was chosen so as to broaden out the curve of the IF response.

The final unit is a two channel affair - a double throw switch switches one of two crystal sockets into the circuit simultaneously with switching one of two trimmers capacitors into the mixer tuned circuit. This permits the converter to be set up on any two frequencies lying between 3.0 and 6.0 megacycles. The over-all physical dimensions are

are 2 by 5 by 13/16 inches. The battery a Mallory TR 120 R with a capacity of 800 ma hour is contained in the unit. Total current drain is three ~~g~~ quarters of a milliampere. Since the rated capacity of the battery is at a much higher drain than this with a maximum drain of 100 ma the life of the battery should be well in excess of a thousand hours of operation with the converter . A conversion gain of 69 (voltagewise) at 3.0 megacycles was noted. At 6.0 megacycles the gain was 55.